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Geomorphic and ecologic fundamentals of the air quality in the vicinity of Kaz Mountains

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Abstract

Lying along the SW-NE direction, Mount Ida is the highest landform on the Biga peninsula in the northwest of Turkey. The highest point of this mountainous mass is the Karataş hill. The purpose of this study is to determine the geomorphological and ecological origins of air quality on and around Mount Ida. To that end, parameters such as temperature, precipitation, wind, and humidity, and geomorphological features such as inclination, elevation, and aspect, and other ecological conditions were determined. Then, these data were linked together and evaluated in terms of their effects on air quality. Mount Ida is a landform consisting of parts that rise in small distances starting from the sea. This landform is split by narrow and deep valleys. These valleys function as a corridor used by air currents because of temperature differences between day and night. Thus, due to the influence of parameters such as orographic features, geographical location, climate, flora and density, and geomorphological features, a strong and constant air circulation occurs on and around Mount Ida. Air circulation in the fieldwork area continually cleans the air, and the lack of industrial facilities contributes to air quality.

Keywords: Kaz Mountains; air quality; geomorphic; ecologic

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1. Introduction

Kaz Mountains are the highest mountain of Biga Peninsula located in the northwest of Anatolia. Kaz Mountains divide Aegean and Marmara Regions. The mountain range which starts to the west of Küçükkuyu in the north of Edremit Bay joins Armutçuk Mountains that lay in the west of Gönen in the vicinity of Yenice by continuing with a few ranges and secondary units. Some parts of Kaz Mountains are located in the borders of Çanakkale whereas other sections are situated in Balıkesir provincial borders. Parts of Kaz Mountains are Gürgen Mountain, Katran Mountain, Eğrikabaağaç and Susuz Mountains from the main mass which housesthe highest peak called Karataş hill (1774 m) to the northeast and the eastern branches are Sakar Mountain, Atkayası, Öbekalan Mountain, Eybek Mountain, Kavsaral Mountain, Büyükçal and Şap Mountains. Kaz Mountains Range is a geomorphologic unit composed of metamorphic rocks with granodiorites at the core. There is an approximately 70 km long fault line in east-west direction along the south side of the range in the north of Edremit Bay.

Fig.1.Location of the Study area

2. General Geographic Attributes

Kaz Mountains Range has three hills located on the actual Kaz Mountain mass in the north of Edremit Bay (Baba Mountain in the north, Karataş Hill in the middle and Sarıkız Hill in the south). The highest point in Kaz Mountains is Karataş Hill with a height of 1774 m.

Some parts of Kaz Mountains are situated in the Aegean Region and some parts are in the Marmara Region. Kaz Mountain was called "Ida Mountain" in ancient times. The deep canyons and valleys that lay in the north-south direction on the mountains provide air currents.

Around Edremit Bay, there are plains made up of alluvials carried by flood water and rivers resourced in the high mountain area in the north.

Geologically, the oldest units in Kaz Mountains, where several formations from Paleozoic to Quaternary are observed, are Kaz Mountain metamorphites composed of schist, gneiss and marble. Major rivers are Edremit Stream, Zeytinli Stream, Kızılkeçili Stream, Ihlamur Creek, Güre Stream, Kuru Creek, Manastır Stream, İskele Creek, Şahin Creek ve Mıhlı Stream, Tuzla Stream, Karamenderes Stream and Gönen Stream. These water courses are fed by branches born from Eybek ann Kaz Moutains and discharge into Aegean and Marmara Seas. The valleys created by Manastır Stream and Şahin Creek are the most important canyons of Kaz Mountains. Kaz Mountains and its close vicinity are very rich in terms of above and underground waters. Thermal and mineral water are found in the area dues to the existence of fault lines.

3. Climactic Features

There are climactic differences between the south side and northern slopes of the mountains. The effect of Mediterranean climate is stronger in the south and Marmara transition climate is visible towards the north.

Table 1. Annual and monthly Precipitation in Edremit

Data	MONTHS												Annual
	1	2	3	4	5	6	7	8	9	10	11	12	
Precipitation (mm)	113.9	86.7	70.2	45.6	32.3	13.6	4.5	3.9	14.2	48.0	106.4	127.6	666.9

3.1. Temperature and Precipitation

Mediterranean and Marmara transition climate are dominant in Kaz Mountains and its close vicinity. Mediterranean climate is effective in the southern parts and Marmara transition climate is visible in the northern sections. With the increase in elevation, temperatures fall and the effects of mountain climate are observed in higher parts. Summers are arid and hot, winters are warm and rainy. There is a 4-5 months period of arid and hot weather during the summer. Hot temperatures are more effective in lower areas and coastal zone. The effect of temperature is lower away from coasts. Winter is warm in low areas and snowy and cold in higher areas. Most of the precipitation occurs in winter months.

As an orographic factor, Kaz Mountains cause vertical changes in the climate which means Mediterranean climate characteristics are more effective only up to 500 m elevation around Edremit Bay. The moderate characteristics of climate disappear in higher ground and summer temperatures lose their effect as well. Snow and frost can be observed throughout six months in the peaks of Kaz Mountains. The average highest temperature which is 27oC in the coasts drops to 18°C and below. The climactic contrast which occurs in an 8 km horizontal distance between the coasts and the mountainous area also causes local climactic areas. The suffocating temperature along the coasts during the summer leaves its place to cool air. Therefore, mountain tourism opportunities are offered in specific periods of the year (summer season). The average highest temperature in 500 m elevation is 23°C and the average lowest temperature, 4,5°C, is observed in January. Temperatures drop along with increases in elevation. For instance, January and February average for 1700 m is below 0°C.

Table 2. Montly temperatures (°C) in different elevation levels

Elevation	MONTHS												Annual
	Jan	Feb.	March	Apr.	May.	June.	July	Aug.	Sept.	Oc.	Nov.	Dec.	
30 m	7.1	7.7	9.7	14.2	19.3	23.8	26.2	25.7	22.1	16.7	12.0	9.0	16.1
500 m	4.6	5.2	7.2	11.7	16.8	21.3	23.7	23.2	19.6	14.2	9.5	6.5	13.6
1000 m	2.1	2.7	4.7	9.2	14.3	19.8	21.2	21.7	17.1	11.7	7.0	4.0	11.3
1700 m	-1.4	-0.8	1.2	5.7	11.0	15.3	17.7	17.2	13.6	8.2	3.5	0.5	7.6

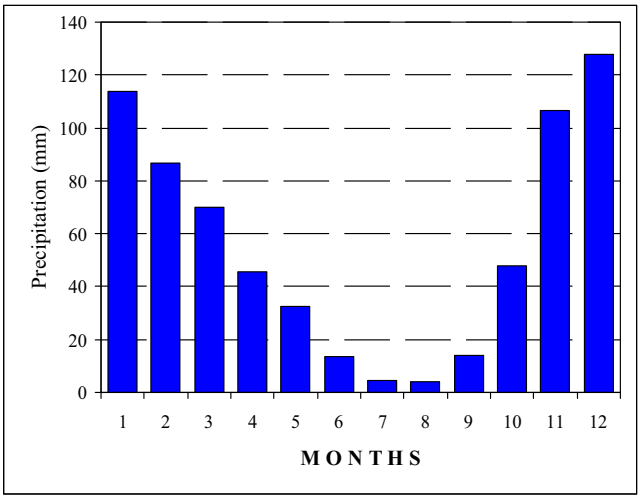

Fig.2.Monthly precipitation Diagram of Edremit

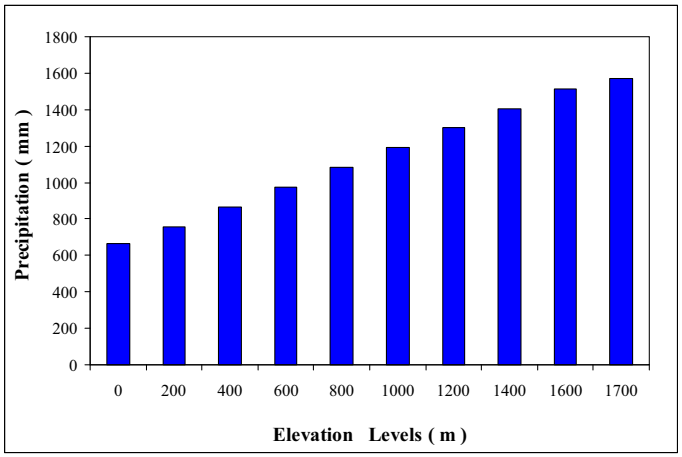

Fig. 3. Relationship of elevation and precipitation on southern part of Kaz Mountains

July is the hottest month in this elevation with an average of 17.7°C. Annual average temperature in areas closer to the peaks of Kaz Mountains is 7.6°C and total annual precipitation is 1500 mm.

3.2. Winds

One of the fundamental parameters that form climactic characteristics is the wind. Winds affect the area in several ways. While some of the winds that blow in Edremit Bay are based on global pressure zones and the others are caused by local physical conditions.

North-easter: The dominant wind direction in the field throughout the year is the northeast. North-easter arrives at the Edremit Bay through the Havran-Edremit valley. North east winds blow warm-dry during the winter and spring and they blow hot-dry during the summer and the fall. When north-easter blows, weather around south facing slopes of Kaz Mountains and Edremit Bay is always clear, open and sunny and the sky is deep blue.

South-wester: The ratio of the winds that arrive over the Aegean Sea is approximately 25% and the most important of them is the southwester which blows from the southwest. Southwester blows during the winter and the spring the most and brings humid and warm air and precipitation. Some of the precipitation that falls on the south slopes of Kaz Mountains is related to the winds that arrive over the sea. However it is a known fact that southwester sometimes increases its severity and causes storms and damage in the bay. Edremit Bay vicinity is open to west sector winds due to the geomorphologic layout of the coasts.

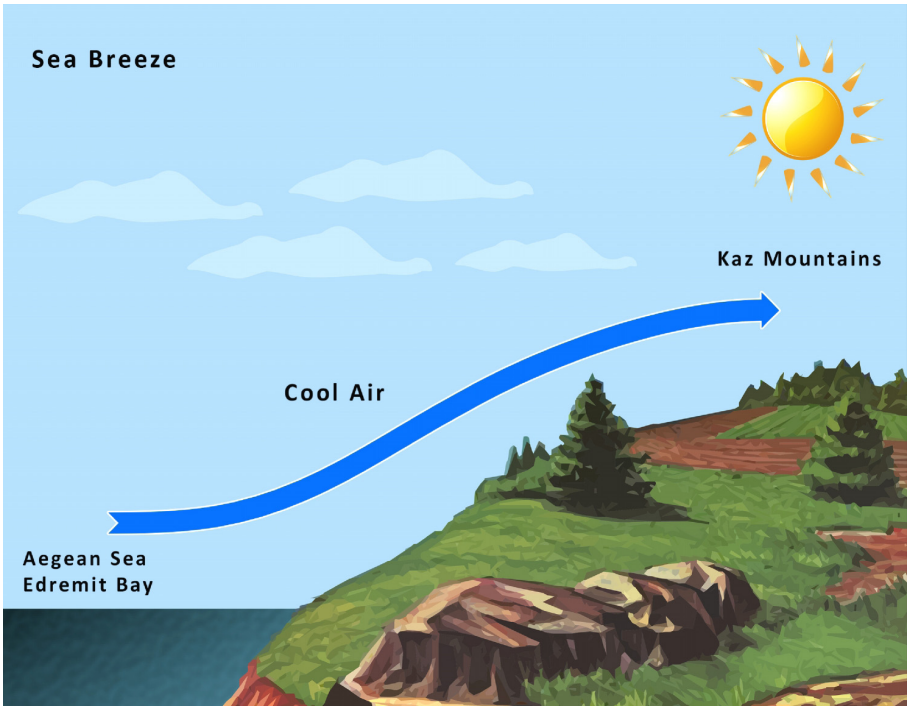

Fig. 4 . Sea Breeze: The sea is cooler compared to land during the day and cool air comes towards to the land. The air on the sea is denser and pressure is higher. The pressure in the land is lower. The air in high pressure moves towards to the low pressure area on land and slopes of Kaz mountains. During hot summer days, this is by far the most preferred weather type and is considered a blessing.

4. Breeze in the vicinity of Edremit Bay

Breeze is the air conditioner of the lowland and slopes in Kaz Mountains. Breeze is the secondary group of winds that affect the southeastern slopes of Kaz Mountains form as a result of pressure differences related to physical geography conditions. Highly important temperature differences occur in short distances due to marine environment

and the very high mountain just nearby and it causes differences in pressure. Therefore, local winds called meltem (breeze) winds are generated in the summer in which differences in temperature increase in the area.

These winds which blow from the Aegean sea to the land (Kaz Mountains) during the day and from the land to the sea during the night decrease the effect of the apparent temperature and generate a pleasant and refreshing air by relieving it from its suffocating effects. The deep valleys of the rivers that flow from Kaz Mountains also canalize these air currents and create a continuous air circulation between the mountain and the coasts by making the air currents more effective. River valleys situated in the southern facing slopes of Kaz Mountains also canalize these air currents. Şahindere valley close to Altınoluk is the vicinity where this event typically takes place. The area is known as "one of the places on earth where the level of oxygen is the highest" due to its clean air refreshed by the continuous circulation.

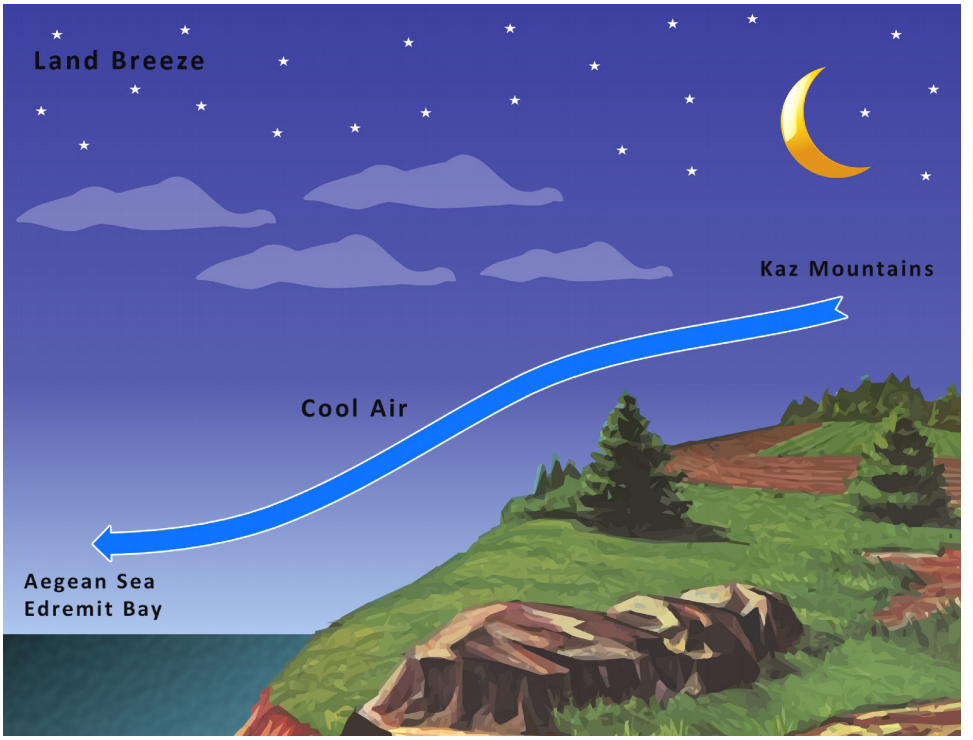

Fig.5. Land Breeze. At night, the sea-breeze usually changes to a land breeze, due to a reversal of the same mechanisms.

The air moves from Edremit Bay which is a high pressure area to Kaz Mountains which are low pressure areas.

At nights, land is cooler and the sea is warmer. Etesian winds blow from Kaz Mountains to Edremit Bay due to the differences in temperature. At nights, the air above Kaz Mountains is denser and the pressure is higher. Since the sea water is warmer, the air above the sea warms up and its pressure falls due to decreases in density. Therefore low-pressure is created above the sea. As a result of this, winds blow from the high pressure are in Kaz Mountains towards the low pressure areas in Edremit Bay. Etesian winds continue until the sun rises in the morning and warms up the land and the differences in temperature is removed.

5. Air in Kaz Mountains: Oxygen Resource Kaz Mountains (Oxygen Tent):

Kaz Mountains range is known with its fresh air and abundant oxygen. The fact that the air in Kaz Mountains is clean (and with abundant oxygen) can be explained with the situation of the gases and pollutants in the atmosphere.

Air is highly important for human life. But clean air is of capital importance for human. Clean air can be observed in areas where the natural structure of the atmosphere and the other –ecosystems are conserved. There are many gases that provide life on earth. Oxygen is the most important among these gases. Oxygen is one of the fundamental elements of life. Cycles in the ecosystem are possible only with the interaction between living and non-living elemants. Living beings go on with their lives much more easily in healthy ecosystems. Among the gases in the atmosphere, O_2 and N_2 cycles are closely related to living beings. O_2, the source of life, is produced mostly by plants and algae in the water. It is consumed by humans, animals and burning of fossil fuels. Plants also produce oxygen at nights. Nitrogen (78.084%) and Oxygen (20.946%) ratios in the air is 99% and the remaining 1% is composed of several other gases. For example, if we weigh 100 liter (100 dm3) air and separate it into all available compounds we will get 78 liter nitrogen, 21 liter oxygen and 1 liter of other gases.

Amount of oxygen does not normally show big changes on earth. The cleanliness of the air is not related to high levels of oxygen but to the existence of pollutants.

Table 3. Gasses in the air -The primary Gassess make up of Dry Air

Gas	**Formula**	**Percentage (%)**	**ppmv**
Nitrogen	N_2	78.084	780,840
Oxygen	O_2	20.946	209,460
Argon	Ar	0.934	9,340
Subtotal		99.964	999,640
Other gasses			
Carbon dioxide	CO_2	0.039445	394.45
Neon	Ne	0.001818	18.18
Helium	He	0.000524	5.24
Hydrogen	H2	0.000055	0.55
Krypton	Kr	0.000114	1.14
Methane	CH_4	0.0001790	1.79
Nitrogen oxide	N_2O	0.0000325	0.325
Carbon monoxide	CO	0.00001	0.1
Xenon	Xe	0.000009	0.09
Ozone	O_3	0-0.000007	0.0 ile 0.07
Nitrogen dioxide	NO_2	0.000002	0.02
Iodine	I_2	0.000001	0.01
Ammoniac	NH_3	trace	
Total		100	1000,00

Volume: ppmv

Gases in the air can be classified in three groups:

- Gases that can be continuously found in the air whose amounts do not change: nitrogen, oxygen and other gases
- Gases that can be continuously found in the air whose amounts increase or decrease: carbon dioxide, water vapor and ozone
- Gases that are not always found in the air: pollutants (gases, dust)

Pollutants are sulphur dioxide (SO_2), nitrousoxide (NOx), hydrocarbon (HC), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbon gases (CFC-H).

Pollutant dust is composed of fumes, metallic fumes, volatile ash, mist and aerosols.

In addition to these, photochemical oxidants such as ozone (O_3) and PAN (peroxyacetyl nitrate) and PBN (peroxybenzol nitrate) are secondary pollutants.

Sources that pollute the air are divided into two:

- Natural sources
- Sources resulting from human activities

The natural sources of the pollutants are volcanic eruptions; forest fires and dust storms. Main anthropogenic sources are motor vehicles, planes, trains, ships, thermic plants, industrial facilities, solid waste burning facilities, solid, liquid and gas stoves and heating boilers.

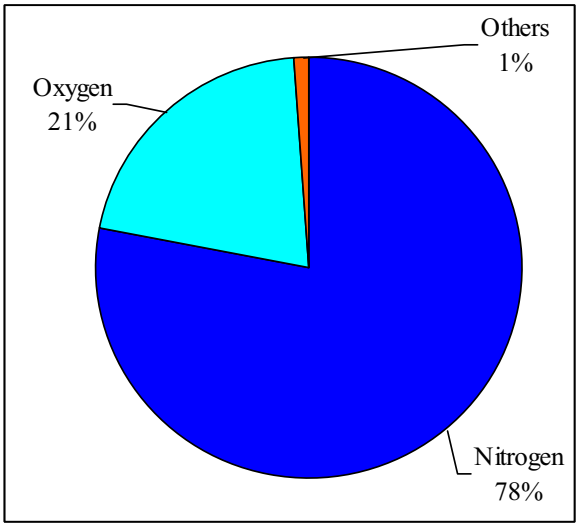

Fig. 6. Gasses make up the atmosphere

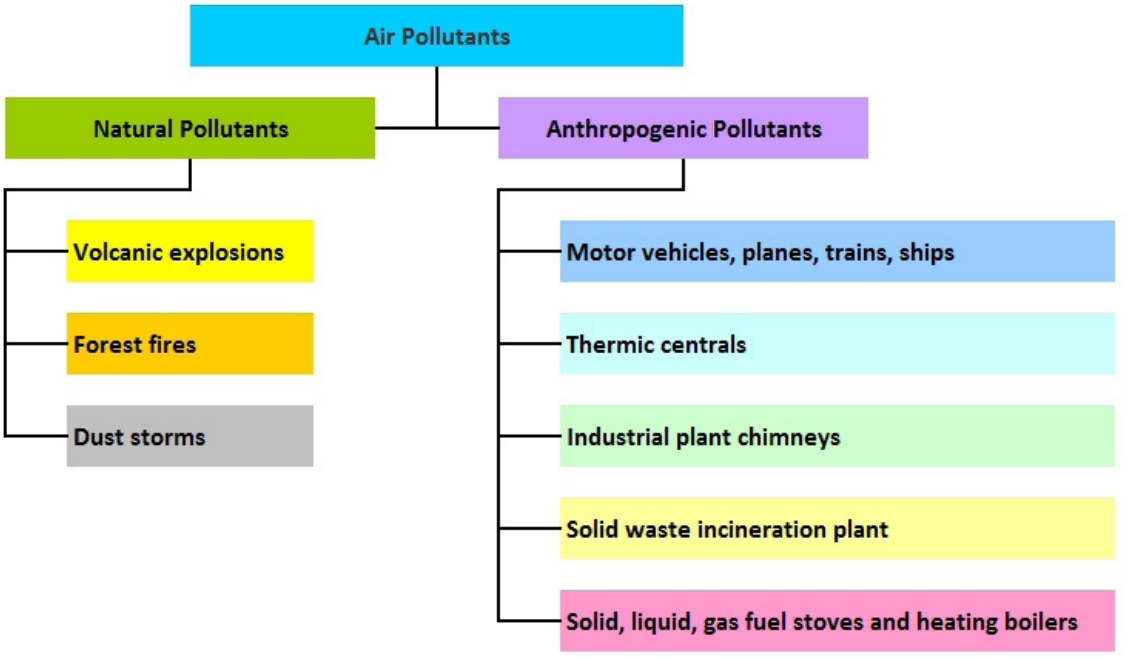

Fig. 7. Air Pollutants

Green plants provide 98% of the oxygen in the atmosphere through photosynthesis. Blue green algae in the seas and other minor but very important organisms create half of the oxygen generated by photosynthesis. The green plants in the land generate the other half. The remaining 2% is produced by breaking the water molecules with the help of ultraviolet radiation and several chemical reactions.

Due to this characteristic, the areas that contain green plants both in land and in the sea are important sink areas for CO_2. Destruction of forests and deforestation causes increases in the amount of CO_2.

5.1. Does the amount of oxygen in the air increase?

The amount of oxygen in the atmosphere is ideal and the levels below or above this is dangerous for life. Oxygen is a highly reactive element. Each 1% ratio of oxygen on top of the original 21% will increase the possibility of lightning to start a fire forest by 70%. On the other hand 5% increase in the amount of oxygen will cause forest fires to start easily and the destruction of all plants on earth.

Each breath fills our lungs with half liter of fresh air. Therefore, we consume 12.000 liter air daily. Since a liter of air is 1.29 gram, we use up more than 15 kg air. Since the air is colorless and odorless, its presence is not immediately visible unless it is in the form of wind.

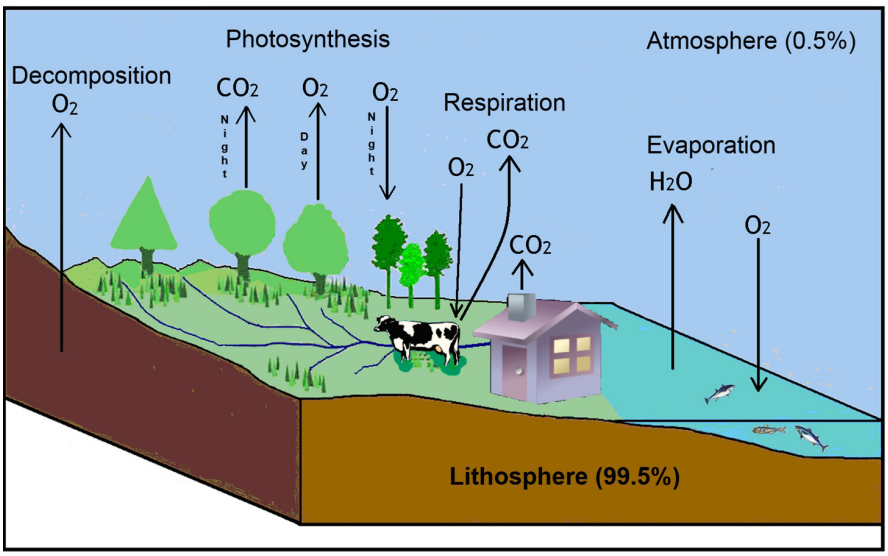

Fig. 8.Oxygen Cycle (After Efe, 2010)

5.2. Characteristics of air and the situation of oxygen in Kaz Mountains and its immediate vicinity:

There are of course reasons for the abundance of oxygen in Biga Peninsula and Kaz Mountains. The sources that produce oxygen in Kaz Mountains are abundant. The main sources that produce oxygen in Kaz Mountains are the Aegean Sea and the flora in Kaz Mountains. Seas and flora are the sources that produce the most oxygen in eco systems. Edremit Bay is located in the south and west of Kaz Mountains. The oxygen produced by Edremit Bay is carried towards the coast and the slopes of Kaz Mountains with the help of the winds.

Edremit Bay and the Aegean Sea that surrounds the bay from the west produce half of the oxygen. Also, forests, maquis and olive groves as agricultural areas provide the other half of the oxygen.

The general circulation of the atmosphere in the area around Biga Peninsula ensures freshening of the air continually. After canalizing in Çanakkale Strait, north-easter also canalizes between Bozcaada and Biga Peninsula as the dominant wind. Later it turns east and infiltrates Edremit bay. It passes through Müsellim Strait between Lesbos Island and coast of Kaz Mountains. There is another channel of circulation between Lesbos Island and

Ayvalık Coasts. Both north-easter and southwester are canalized between Lesbos and Anatolian coasts. Therefore, an annual non-stop air circulation is generated around the peninsula on which Kaz Mountains range is located. Hence the air in the area is always refreshed and cleansed. It is not possible to find such a mechanism in any other parts of Turkey.

There is also a vertical circulation mechanism in Kaz Mountains caused by the differences in elevation. This mechanism is created as a result of temperature differences between high mountains and the sea and generates etesian winds. Especially in the summer when thermic gradient increases, etesian winds, that blow from the sea to the land during the day and from the land to the sea during the night, are created (sea and land etesian winds). Therefore, etesian winds step in the periods when the winds caused by general pressure conditions lose their effects and they help continue the circulation and clean and refresh the air. Valley gulleys with north-south directions that fracture the mountain ensure the increase in impact by canalizing these winds.

Pollutants are ineffective in and around Kaz Mountains. Dust storms are rare. Forest fires are sometimes seen. Other than these, a natural pollutant factor is nonexistent.

Fig. 9. Gorges cut the Kaz Mountain in the north-south direction canalize the air masses.

Fig. 10. Karamenderes river valley

Fig. 11. Şahindere Valley: valleys that deeply fracture Kaz Mountains canalize air currents. Şahindere Canyon is one of these.

Gases discharged by motor vehicles are important as anthropogenic pollutants. İzmir- Çanakkale, Balıkesir-Çanakkale, Balıkesir - İzmir highway pass the coastal area and intersect. There is heavy traffic all through the year in these highways. However, density of the flora and the sea areas have the capacity to absorb the pollutants comfortably and the air pollution that results along the roads is not felt. In addition to this fact, establishments that release pollutants into the atmosphere such as big industrial facilities and thermal plants do not exist in the area. The circulation and cleansing capacity of the area is always more dominant compared to pollution effects. Therefore, Kaz Mountains can still preserve the attribute of being one of the parts of Turkey with high level of air quality.

In addition to drops in temperature and humidity with increases in elevation, there are also important changes in the amount of oxygen in the air we breathe. One fifth of the gases in the air is oxygen in the air at sea level. The amount of oxygen does not change even when the elevation is 3000 m. However, the fact that the ratio of oxygen is 20,946% in higher elevations does not mean that we take the same amount of oxygen to our lungs with each breath. The pressure of the atmosphere decreases with increases in elevation and the oxygen molecules in it become sparse. We have to breathe more often and more deeply in order to receive the same amount of oxygen intake.

There is a very available environment in the southern facing slopes of Kaz Mountains and coastal zone caused by climactic natural conditions. There is a continuous air circulation between the high parts of the mountain and the sea and the lower coastal zone. Light/medium strength winds and coastal etesian winds observed throughout the year provide refreshing and comforting environment with less than 60% humidity.

6. Results

Kaz Mountain system and its close vicinity stand out as a strong area with a continuous air circulation due to the orographic characteristics such as geographical location, climate, dense flora and geomorphology. Therefore air in the vicinity is always refreshed and cleansed. The effects of anthropogenic pollutants are minor since it is not an industrial area. Therefore, Kaz Mountains always stand out as an area where air quality is always good.

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